THE MOLLUSCAN FAUNA OF THE PLIOCENE STRATA UNDERLYING THE ADELAIDE PLAINS

PART I

By N. H. Ludbrook *

[Read 9 April 1953]

SUMMARY

The molluscan fauna of the South Australian Pliocene is best developed and preserved in the Dry Creek Sands which have been thrown down to the west of the City of Adelaide by the Para Fault.

Pliocene strata were deposited unconformably on a post-Burdigalian erosion surface, and are overlain by Pleistocene to Recent sands and clays, mainly of freshwater origin, and nodular kunkar. In the Adelaide Basin shell heaps concentrated by currents are frequent in the north-eastern portion, and are of economic importance since they generally mark the aquifer.

Readily distinguishable lithologically, the light-grey fine sharp quartz sands carry a well-preserved rich molluscan fauna, mainly of the epineritic environment.

The mollusca constitute essentially a tropical marine fauna in which four distinct elements may be recognized: a dominant Indo-Pacific, a Tethyan Eocene, a Recent Australasian, and a cosmopolitan. The presence of undoubted Tethyan Eocene subgenera is of particular interest. The stage at which these reached Australia is not at present determinable, but it is likely that they date at least from the Oligocene. Distinct from the two tropical elements are a large autochthonous Australasian element probably derived from an endemic stock, and a fourth element composed of cosmopolitan or widespread subgenera.

Since 57% of the species are restricted to the fauna, the age is determinable only by correlation with known Pliocene faunas in Australia. Available evidence suggests that the strata may be slightly younger than Pliocene strata ("Kalimnan") in Eastern Victoria, but much work remains to be done before complete correlation is achieved.

I. INTRODUCTION

During the past 70 years the Adelaide Plains, comprising the eastern portion of the St. Vincent Gulf—Adelaide Plains graben on which the City of Adelaide is built, have been at first intermittently and recently intensively drilled in the search for a supplementary or alternative water supply for the domestic and agricultural needs of the city and its environs.

For the fifty years following the drilling of the first deep hole at Kent Town, close to the city area, borings were sunk at sporadic intervals by landowners for agricultural purposes. With the growth of the city and threatened failure of normal water supply from storage reservoirs in times of drought, a programme of drilling was initiated by the South Australian Mines Department in 1934 and greatly intensified in 1945. The area drilled covers some 250 square miles from the Gawler River 18 miles north of Adelaide, south to Brighton 9 miles south-south-west of the city, bounded on the west by Gulf St. Vincent and on the east by the foothills of the Mount Lofty Range along the line of the Burnside and Eden Faults.

Practice has been to seal the Government bores until drought necessitates opening them to supplement the city water supply.

Material from several of the borings was submitted to the writer by the South Australian Mines Department for palaeontological examination. Results of examination of the mollusca are embodied in the present study.

During the past twenty years, Australian molluscan systematics have become confused by the reluctance of some workers to recognize generic affinities between most of the Australian species and their relatives elsewhere. As a result, accurate

* Department of Mines, South Australia.

and detailed correlation of faunas has not been attempted. An additional problem arises from the fact that faunas from type areas are imperfectly known. Collecting has been done from easily accessible localities where fossils are numerous, but little systematic sampling has been carried out.

With the aim of reducing some of the anomalies so created a representative series of the mollusca contained in the bores submitted to the writer was taken to London for comparison with type and other material in the British Museum. The fauna has now been completely revised and the nomenclature brought into line with that employed by specialists outside Australia.

The stage name "Adelaidean" previously in use for the strata is abandoned in accordance with the suggestion of Mawson and Sprigg (1950, p. 69). Howchin (1928, p. 422) proposed the term for the richly fossiliferous marine sub-surface strata, which he considered to be of Upper Pliocene age, known only from borings within short distances of Adelaide. Since confusion is always likely to arise from the use of the term Adelaidean for the Pliocene marine sands when there is the well-established Adelaide System (formerly Series) of Pre-Cambrian age, Glaessner (1951, p. 280) has recommended its replacement by the name Dry Creek Sands.

II. HISTORICAL SURVEY

The Dry Creek Sands were first discovered in 1889 when a deep bore in search of water was sunk at Dry Creek, 6 miles due north of Adelaide, by the Australian Smelting Company. On this classical boring the discovery of marine deposits younger than beds then considered to be of Miocene age and older than admitted Pleistocene strata was claimed.

In the following year a bore was sunk at Croydon 3½ miles north-west of Adelaide and reported upon by Tate (1890 b), who published a section showing that the Pliocene strata recognized in the Dry Creek Bore were penetrated at 340 feet; a thickness of 406 feet for the Pliocene was postulated. The boring was stopped at 800 feet. Subsequently a second bore was sunk at Croydon to a depth of 2,296 feet, adjacent to the first. The Pliocene and underlying strata were again reported upon by Tate (1898), Pliocene being identified from 395 to 715 feet.

No detailed palaeontological work was done to advance the knowledge of the fauna, although varying and speculative opinions on the age of the strata and their relative stratigraphical position were published. These may be briefly summarized as follows:

Tate and Dennant (1896, p. 148) placed them above the beds now known as Kalimnan in Victoria and in the Pliocene.

Hall and Pritchard (1902, p. 80) named the Kalimnan (p. 78) and considered the beds described by Tate from Dry Creek to be contemporaneous and therefore of "Miocene" age.

Howchin (1914, p. 156) differentiated them from the Kalimnan ("Second Marine Series? Miocene") as "Third Marine Series—Older Pliocene."

Chapman (1916, p. 156) accepted the view of Hall and Pritchard that the beds were contemporaneous with the Kalimnan, but supported the earlier view of McCoy and the Geological Survey of Victoria that the Kalimnan was Lower Pliocene in age.

Howchin (1928, p. 422; 1929, p. 235) introduced the name Adelaidean, and "proposed to distinguish . . . . the Adelaidean Upper Pliocene" from the Werrikooian Upper Pliocene of Victoria.

In a preliminary note on the stratigraphical position of the beds the writer expressed the view (Ludbrook, 1938, p. 445) that the beds now known as the Dry Creek Sands were probably contemporaneous with other beds of accepted Lower Pliocene age in Southern Australia. This opinion was strongly opposed by Howchin and Parr (1938, p. 289) and Parr (1939) who continued to maintain an Upper Pliocene age for the fauna. Chapman (in Howchin and Parr, 1938, p. 290) agreed with Howchin that the Dry Creek Sands were younger than the Kalimnan, but considered them contemporaneous with the Pliocene beds at Hallett Cove.

Singleton (1941, p. 22) established and defined the Adelaidean as a Stage.

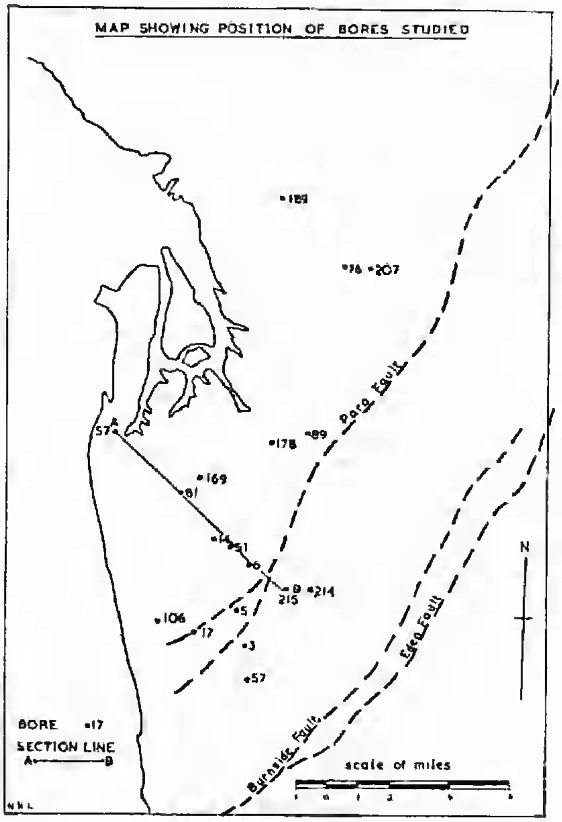

Fig. 1
Bore 215 is within the boundary of the City of Adelaide.

On completion of a systematic study and analysis of the gastropod fauna of Abattoirs Bore, and taking into account the view of Howchin and Parr that the foraminifera had a more recent aspect than those of the Kalimnan, the writer (1941, p. 80) placed the Dry Creek Sands in the Lower-Middle Pliocene.

Since the present work was completed the publication of a comprehensive report on the geology and underground water resources of the Adelaide Plains area (Miles, 1952) has added greatly to the knowledge of the subsurface geology of the area. In an appendix to the report Crespin and Cotton (1952) have correlated the Pliocene strata with the Kalimnan of Victoria, the faunal differences being attributed to facies.

In the present study the molluscan fauna has been increased to 380 species, 78 of which have not been previously described; four new subgenera have been erected. The composition of the fauna has been determined as accurately as possible, its relationships with other comparable faunas analysed and its bearing upon the stratigraphical position of the strata discussed. The establishment beyond doubt of a faunal link between the European Eocene, Australian Pliocene, and the Recent Indo-Pacific Region is an important fact to emerge. Some faunal migration, probably by way of Tethys, has almost certainly taken place, and closer study of faunas linking Australia to the Northern Hemisphere is warranted. There is at present no evidence of any faunal link with known American Tertiaries, and the study confirms the opinion that the deep waters of the Pacific Ocean have always been a barrier between the faunas of its western shores and those of the east, except in the extreme north and south where movement along the coastline has been possible.

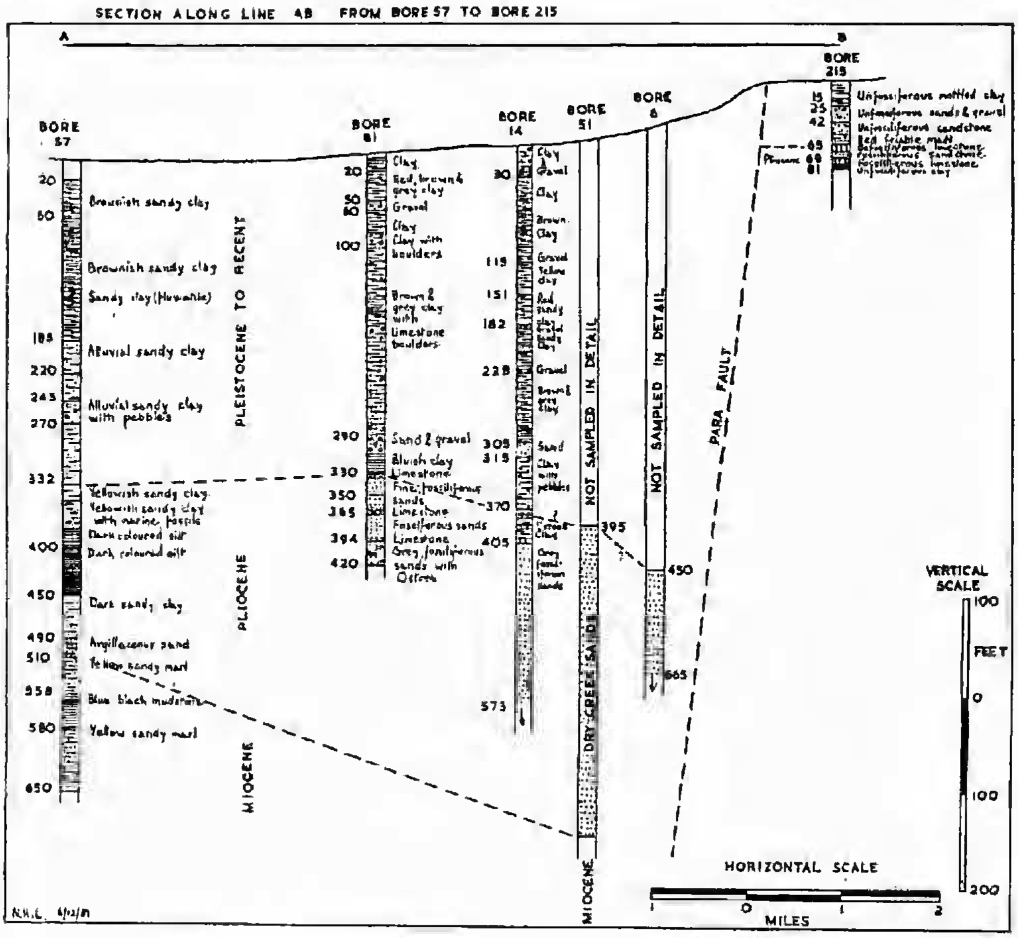

Fig. 2

III. GENERAL AND STRUCTURAL GEOLOGY

Pliocene strata are exposed as isolated remnants at irregular intervals along the eastern coast of Gulf St. Vincent from Aldinga Bay in the south to the City of Adelaide in the north (Howchin, 1923; Segnit, 1940). Pliocene limestone formerly outcropped along the banks of the River Torrens (Howchin, 1923, p. 283) and has been exposed in quarries on the south bank of the River at the rear of Government House (Tate, 1882, p. 40) and in the University grounds. It has been frequently penetrated in shallow well sinkings and in borings in the City area at about 50 to 70 feet depth, including Kent Town Bore (Tate, 1882), Black Forest Bore (Howchin, 1935), Bank of the New South Wales Well (Cotton, 1947), and was noted by the writer in West End Brewery No. 2 Well, Hindley Street, at depth from 69 to 70 feet. Fossils typical of the Dry Creek Sands were present mainly as moulds. Elsewhere the Pliocene has been penetrated only by borings into the Dry Creek Sands from Gawler River in the north to Glenelg in the south. The average depth below datum level at which the beds are penetrated is 315 feet. Where the thickness is proved, the beds are generally from 150 to 180 feet thick, although an exceptional thickness of 320 feet was passed through in the Croydon Bore (Tate, 1898, p. 195). The average thickness in six bores which reached the Miocene is 190 feet.

The greater thickness of the Dry Creek Sands as compared with that of the sandy limestones in the City area and in exposures south of Adelaide is consequent upon tectonic movements which disturbed the area in late Tertiary and Quaternary times. The Mount Lofty Ranges and Adelaide Plains are units in a system of regional meridional block faulting in which the St. Vincent Gulf-Adelaide Plains form a graben and the Mount Lofty Ranges a horst to the east. The general structure of the fault system has been described chiefly by Benson (1911), Fenner (1930), and Sprigg (1945). The major faults in the Adelaide Plains and Western Mount Lofty Ranges are shown on fig. 1 The trend lines are broadly N.N.E. - S.S.W.

Fenner (1930, p. 15) has suggested that two periods of block faulting are probably involved; while there is at present no direct evidence that this is the case, it is not improbable that the orogenic movements which elevated the Mount Lofty Ranges horst antedated the deposition of the Dry Creek Sands and their subsequent down-faulting to the west of the Para Fault.

To the south and east of the Para Fault in the immediate neighbourhood of Adelaide only the more resistant calcareous equivalents of the Dry Creek Sands have been preserved at shallow depth. West of the Para Fault, however, the sediments have been thrown down to a maximum of the order of 350 feet, and an average thickness of 190 feet of unconsolidated sands has been preserved beneath a cover of later marine and freshwater sediments. The subsurface relationship of the Dry Creek Sands to the overlying and underlying sediments and to the Para Fault is shown in the section (fig. 2) drawn along the line AB of fig. 1. The position of the Pliocene remnant underlying the City is shown by the narrow band 69 feet below the surface in Bore 215 to the east of the fault.

IV. SEDIMENTATION AND LITHOLOGY

The Dry Creek Sands and their equivalents in the Pliocene were deposited in a shallow bay or gulf of the Pliocene seas after the depression of the older strata which had been reduced to base surface at the end of the Mesozoic and submerged during the early Tertiary.

At the close of the Lower Miocene a cycle of erosion occurred in South Australia, where, unlike Eastern Victoria, no continuous sequence from Lower Miocene to Pliocene is revealed and a marked unconformity separates the Pliocene from the underlying strata, the youngest of which are Lower Miocene, with the restricted Lower Miocene foraminifer, *Austrotrillina howchini*.

On this Tertiary erosion surface the Dry Creek Sands and the sandy limestones were deposited. As revealed in the borings, the Dry Creek Sands are a well-defined lithological and palaeontological unit usually readily distinguishable from the underlying earlier Tertiary strata. The Miocene is generally but not always a yellowish sandy marl or calcareous sandstone. The sand grains are frequently much encrusted. Overlying the Miocene, the light-grey or silvery, fine, sharp Pliocene sands and clays, carry a rich marine fauna. Intercalated bands of grey and white limestone occur apparently irregularly throughout the strata. Present knowledge does not permit the correlation of these bands in any way. They may be the equivalents of the more resistant members of the Pliocene which underlie the City to the east of the Para Fault, but the writer's opinion is that the sandy limestones to the east of the Para Fault represent the shallow littoral facies.

Bores examined in detail demonstrate that very fossiliferous bands occur at more than one level in the Pliocene, their position probably being determined by the operation of currents in the bay in which the sands were deposited. The indication is that the general direction of such currents was north-easterly. This would account for the unusually rich bands penetrated in Abattoirs, Weymouth's, and Salisbury Bores in the north-eastern portion of the basin. These highly fossiliferous bands were not deposited evenly on the floor of the

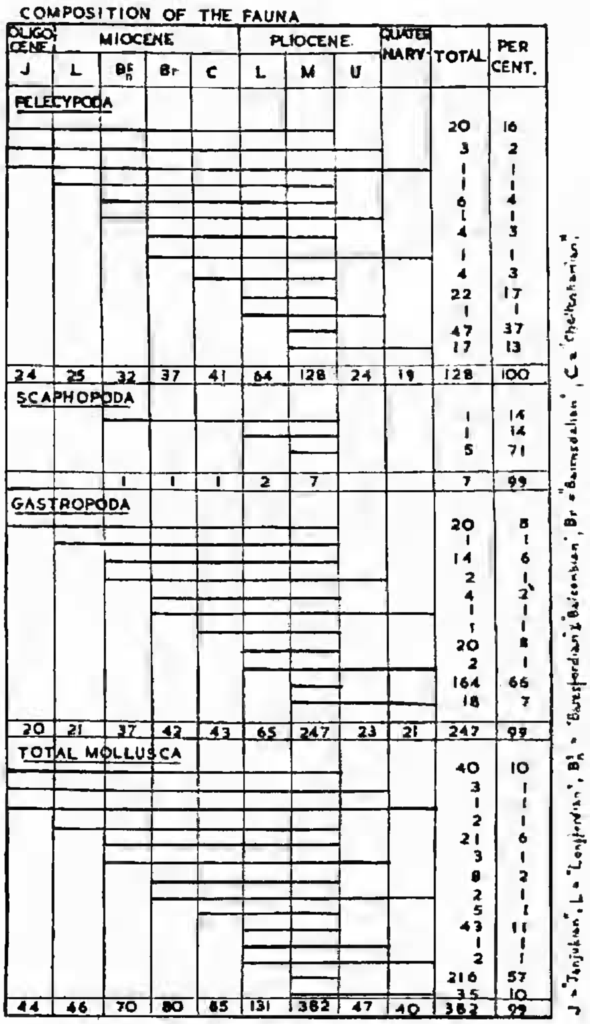

Fig. 3

basin in still water, but were produced by the concentration of shells along the shore lines by surface currents. Variation in intensity of the currents would account for the uneven distribution of the load. As the highly fossiliferous shelly band is most frequently the aquifer, boring generally stops when it is reached. Where the band has been passed through and the boring continued, less fossiliferous strata are revealed.

Overlying the Dry Creek Sands are approximately 300 feet of superficial clays, sands, and gravels of Pleistocene to Recent age of alluvial deltaic origin consequent upon the uplift of the Mount Lofty Ranges horst. They form a belt of piedmont alluvium widening northwards and about 10 miles wide in the immediate vicinity of Adelaide. North of Adelaide remains of extinct marsupials, including *Diprotodon*, have been found in the alluvium.

Except for two recent incursions of the sea, each represented by less than five feet of sediments (Miles, 1952, p. 32) there was no general submergence of the Adelaide Plains during the Quaternary.

The downward succession from Recent to Miocene may be exemplified by Filsell's Bore (No. 169), examined by the writer and sampled to a depth of 530 feet when boring ceased in the Miocene:

Surface – 302 feet.	Clays and gravels of Pleistocene to Recent age.
302–317 feet.	Greyish-brown fine glauconitic sand with *Rotalia beccarii*, *Ostrea* sp. and *"Mactra"* sp.
317–348 feet.	Greenish-grey silt with a similar fossil content.
348–360 feet.	Fine grey sand, highly fossiliferous, with typical assemblage, mainly mollusca.
360–378 feet.	Fine sharp quartz sand, highly fossiliferous with mostly small mollusca and foraminifera, together with six species of bryozoa.
378–382 feet.	Dark-grey fine fossiliferous sand.
382–396 feet.	Fine silver-grey sand, very highly fossiliferous, with a typical molluscan assemblage, mostly pelecypoda.
396–409 feet.	Fine grey fossiliferous silt, 90% disappearing on washing, with the pelecypod *Condylocardia tenuicostae* and associated but not restricted foraminifera and gastropoda.
409–415 feet.	Fine grey fossiliferous silt.
443–452 feet.	Hard grey fossiliferous limestone.
452–492 feet.	Grey fossiliferous sands with bryozoa and an admixture of Pliocene and Miocene fossil species, indicating that the lowest level of the Pliocene has been reached and the Miocene penetrated.
492–504 feet.	Yellowish sands, much encrusted with calcium carbonate, with the Miocene foraminifer, *Operculina victoriensis* and bryozoon *Mecynoecia proboscidea*.
504–524 feet.	Hard yellow limestone with *Operculina victoriensis* and an associated Miocene fauna.
524–530 feet.	Greyish-brown sands with a similar fossil content.

From the manner of collecting the samples only over broad intervals accurate zoning cannot be achieved. From the surface to 302 feet the typical alluvial clays and gravels forming the surface cover of the Adelaide Plains are probably of Pleistocene to Recent age. These correspond to the 341 feet of sand and clay penetrated in Abattoirs Bore (level of collar 170 feet). From 302 feet to 348 feet the section may be Upper Pliocene in age. No restricted fossils are present; they are generally few, and Recent in character. The Dry Creek Sands occur from 348 feet to approximately 475 feet, the highly fossiliferous band being between the 382 and 396-foot level. Pre-Pliocene beds occur below 492 feet and the lithology shows a pronounced change at that level, the characteristic yellow colour replacing the grey sands of the Pliocene. The Miocene foraminifer *Operculina victoriensis* makes its appearance. The change from Dry Creek Sands to the underlying Miocene may also be indicated by the sudden increase in the number of bryozoa which are not common in the Pliocene, although they do occur in some numbers representing numerous species in certain borings, such as Hindmarsh.

The sandy limestones underlying the City of Adelaide carry Dry Creek molluscs—mainly in the form of moulds of *Turritella* (*Haustator*) *acricula adelaidensis*, *Polinices* (*Conuber*) *balteatella*, and species of *Polinices*, "*Marginella*," *Emarginula*, *Euchelus*, and "*Venus*." Where they are better preserved as in the unleached block removed in the excavations for the foundations of the Bank of New South Wales building the determinable fauna is similar to that of the calcareous sandstones exposed at Hallett Cove and Aldinga Bay, with *Chlamys antiaustralis*, *Chlamys* (*Equichlamys*) *consobrinus*, *Chlamys* (*Equichlamys*) *subbifrons*, *Spondylus spondyloides*, *Ostrea arenicola*, *Glycymeris* (*Veletuceta*) *subradians*, *Diastoma provisi*, and *Polinices* (*Conuber*) *balteatella*. The limestones are allochthonous, of the fossiliferous-fragmental type commonly found in association with quartzose sandstone (Krumbein and Sloss, 1951, p. 139). According to those authors, such associated rocks are deposited under essentially stable conditions with mild subsidence of the depositional area.

V. PALAEOECOLOGY

The environmental and climatic conditions under which the community preserved in the Dry Creek Sands lived are determinable only by the thanatocoenose or assemblage of fossils so well represented in borings such as Abattoirs (No. 89), Weymouth's (No. 207), and Hindmarsh (No. 6). That it is most unlikely that the mollusca existed in life in the position in which they were deposited has already been suggested in the previous section, where the role played by surface currents in deposition of the sediments is briefly described. That many of the mollusca were dead before their shells were deposited is demonstrated by the fact that large numbers of pelecypods and gastropods, many of them very small, have been bored by predatory mollusca, perhaps the *Hinia* (*Reticunassa*) which occurs numerously in the Hindmarsh Bore. Shells were obviously piled in heaps by surface currents operating towards the north-east, such heaps constituting the shelly band of "oyster bed" which is generally the aquifer in the Dry Creek Sands and in which the oyster *Ostrea arenicola* is one of the commonest species.

Notwithstanding the mode of deposition, the fauna is sufficiently uniform for an accurate estimate of the ecology to be made. It has long been recognised that Australian Pliocene and Miocene mollusca belonged in the main to tropical genera chiefly inhabiting the Indo-Pacific region today. However, no serious attempt has been made to correlate them in any detail. The origin and relationships of the Dry Creek Sands fauna will be discussed in detail in the succeeding section and separately, under such species as are concerned, in the taxonomic study of the species.

The Dry Creek Sands carry essentially a tropical marine fauna, with a large percentage of its subgenera represented in the Indo-Pacific region today. The subgenus, as a practical indicator of climatic conditions (Chavan, 1949) has been freely employed throughout this study. The living community now partly preserved in the Dry Creek Sands undoubtedly inhabited a sandy bay of the Pliocene seas with relatively sheltered conditions and little disturbance except from surface currents. Apart from the evidence of differential deposition of load, the presence of bryozoa which require circulating waters for their existence indicates that the sediments were not laid down in still waters. The environment was epineritic, with shallow water species and subgenera prevailing. East of the Para Fault the limestones are more characteristic of the littoral environment and littoral species of *Chlamys* and *Polinices* (*Conuber*) are more common.

The genus *Terebralia*, formerly identified from the Dry Creek Sands and apparently indicating tropical mangrove swamp conditions (Crespin and Cotton, 1952, p. 233) similar to those of the native habitat in Northern Australia, has been erroneously identified. The restricted species described as *Terebralia adelaidensis* Howchin and Cotton is not a *Terebralia* but a *Thericium* belonging to a lineage represented in the Italian Pliocene, Recent Indo-Pacific, and probably the Parisian Eocene.

Tropical subgenera of the littoral or epineritic environment which occur in the Dry Creek Sands include the pelecypoda *Arca, Cucullaea, Pinctada, Sportella, Bellucina, Prophetilora, Vasticardium,* and the gastropoda *Notohaliotis, Laetifautor, Pulchrastele, Calthalotia, Tugali, Gena, Cocculinella, Nina, Pelecydium, Obtortio, Semibittium, Semivertagus, Amaea, Margineulima, Agatha, Pyrgolampros, Cypraeerato, Globularia, Truncularìopsis, Pterochelus, Latiaxis, Fusinus, Baryspira, Turrancilla, Mitra, Tudicla, Cymbiola, Aulicina, Cancellaphera, Gibberula, Closia, Volvarina, Tomopleura, Etrema, Vepreculu, Floraconus.*

Subgenera inhabiting warm seas but with a greater range of thermal tolerance than the above are the pelecypoda *Barbatia, Tucetona, Tucetilla, Chama, Miltha, Regozara,* and the gastropoda *Emarginula, Astele, Phasianotrochus, Euriclanculus, Minolia, Spectamen, Phenacolepas, Tenagodus, Ataxocerithium, Hirtoscala, Niso, Syrnola, Puposyrnola, Turbonilla, Chemnitzia, Pyrgiscus, Cheilea, Sabia, Argobuccinum, Cymatiella, Murexsul, Homolocantha, Phos, Reticunassa, Serrata.*

The distribution table (pp. 56-62) attempts to show the horizontal distribution of each of the species constituting the molluscan fauna recovered from the Pliocene of 14 borings. Bores are arranged from north to south from the most northerly, Tennant's Bore (No. 189), to the most southerly, Brooklyn Park (No. 17). Numbers of the bores are as follows: Tennant's (189), Weymouth's (207), Abattoirs (89), Dry Creek (178), Glanville (57), Filsell's (169), Holden's (81), York (14), Croydon (51), Hindmarsh (6), Bore 65, Cowandilla (5), Kooyonga (106), Brooklyn Park (17). The inference to be drawn from the table is that there is greater concentration of species in the northerly bores, and that in the southerly bores those that are to the east and nearer the Para Fault and the presumed shoreline are more fossiliferous. Such concentrations have been effected apparently on or near the shore line, generally towards the north-east of the bay.

The associated foraminiferal fauna contains a number of genera living today in shallow warm waters, including the Peneroplid genera *Peneroplis, Sorites, Amphisorus,* and *Marginopora. Marginopora vertebralis* is extremely common in some borings, and together with *Peneroplis planatus* is exposed on weathered surfaces of the sandy limestones of the littoral facies. *Rotalia beccarii* is found in almost every sample and is perhaps the most commonly occurring foraminifer in the Dry Creek Sands. Its presence in large numbers is indicative of a bay-littoral environment. Associated with the Peneroplidae and Rotaliidae are species typical of the Recent Flindersian Province such as *Flintina triquetra* (Brady) and *Nubecularia lucifuga* var. *lapidea* Wiesner.

VI. FAUNAL RELATIONSHIPS

Four distinct elements may be recognised in the fauna: a dominant Recent Indo-Pacific, a Tethyan Eocene, a Recent Australasian, and a cosmopolitan.

A. The Recent Indo-Pacific Element

The dominant element in the fauna is Indo-Pacific. Although the tropical character of Australian Tertiary mollusca has always been recognised, no detailed attempt has hitherto been made to correlate Australian Tertiary faunas with the living faunas of the Indo-Pacific Region. With the possible exception of one or two species living today in North Queensland, with which examples in the Dry Creek Sands appear to be conspecific, the fauna has no species in common with the Recent Indo-Pacific, but the resemblance or affinity in many cases is remarkably close and the species are subgenerically identical.

The affinities between species of pelecypoda appear to be less striking than those between gastropod species. This is perhaps due to the fact that the gastropoda are more restricted and generally shorter ranging than pelecypoda, and such affinities as do occur are more conspicuous.

Species of pelecypoda which may be directly correlated with Indo-Pacific or Northern Australian species are: *Monilitora (Prophetilora) chavani* sp. nov. with *M. (P.) arizela* Iredale; *Vasticardium submaculosum* sp. nov. with *V. maculosum* Wood, *V. transcendens* Melvill and Standen, and *V. mauritianum* Deshayes; *Antigona (Proxichione) cognata* (Pritchard) with *A. (P.) listeri* Gray and *A. (P.) reticulatum* Linné; *Gafrarium perornatum* N. H. Woods with *G. dispar* Dillwyn; *Veremolpa protomarica* (Cotton) with *V. marica* (Linne). The scaphopod species *Dentalium (Dentalium) howchini* (Cotton and Ludbrook) is related to *D. (D.) elephantinum* Linné. Affinities in the gastropoda are to be found between *Calliostoma (Laetifautor)* spp. and *C. (L.) deceptum* Smith; *Astele (Pulchrastele) planiconicum* (Ludbrook) and *A. (P.) septenarium* Melvill and Standen; *Thalotia (Calthalotia) nitidissima* (Ludbrook) and *T. (C.) arruensis* Watson; *Clanculus (Euriclanculus) quadricingulatus* Ludbrook and *C. (E.) ceylonicus* G. and H. Nevill; *Isanda (Minolia) pergloboso* (Ludbrook) and *I. (M.) pulcherrima* Angas; *Spectamen planicarinatum* sp. nov. and *S. biangulatum* Adams; *Spectamen praecursor* sp. nov. and *S. sayademalha* Melvill; *Tubiola (Partubiola) depressispira* (Ludbrook) and *T. (P.) carinata*, *T. (P.) quinquecarinata* and *T. (P.) novemcarinata* all of Melvill; *Thericium adelaidense* (Howchin and Cotton) and *T. opportunum* Bayle; *Amaea (Amaea) triplicata* (Tate) and *A. (A) kieneri* (Canefri); *Truncolariopsis peramangus* (Ludbrook) and *T. trunculus* (Linné); *Homolocantha antecedens* sp. nov. and *H. secunda* (Lamarck) and *H. varicosa* Sowerby; *Latiaxis dissitus* Cotton and *L. mawae* (Gray); *Austromitra angusticostata* Ludbrook and *A. capensis* (Dunker), *A. turriger* (Reeve), *A. kowiensis* (Sowerby), *A. capricornia* Hedley; *Tudicla sinotecta* Ludbrook and *T. spirillus* (Linné); *Cymbiola tabulata* (Tate) and *C. pulchra* (Sowerby), *Volvarina* (?) *incommoda* sp. nov. and *V.* (?) *sarcodes* Tomlin, *V.* (?) *serri* Bavay.

B. The Tethyan Eocene Element

One of the most interesting facts to emerge from the attempt to correct the generic and subgeneric locations of the mollusca is that several subgenera well represented in the European Eocene have closely allied representatives in the Dry Creek Sands. This is perhaps not altogether unexpected in view of the dominance of the Indo-Pacific element to which the Tethyan Eocene is ancestral (Martin 1914; Umbgrove, 1930; Davies, 1934, p. 104). It seems somewhat improbable that the Tethyan element in the South Australian Pliocene was introduced by late migration by way of the East Indies. Molluscan faunas of the East Indies and those of the Australian Tertiaries seem to have less in common than might be expected. The most convincing conclusion to be drawn is that the Tethyan molluscan elements had already reached Australia during the Eocene or Oligocene. This is supported by the writer's recent discovery of the subgenus *Bellucina* in clays of probable Eocene age from the South-East of South Australia. Tethyan foraminifera *Nummulites, Discocyclina,* and *Pellatispira* have been recorded from the Eocene of the North West Cape – Cape Cuvier area in Western Australia (Chapman and Crespin, 1935), and additions to the knowledge of the Tertiaries in the North-West of Western Australia may establish the presence of an allied molluscan fauna.

Present knowledge of the affinities of pre-Pliocene Tertiary mollusca from southern Australia is too limited to permit confirmation in more than the one instance cited of the preservation of the Eocene element within the Australian faunas, but that this is the case is more than probable. It is supported by the strong Indo-Pacific affinity of the foraminiferal and molluscan faunas of the Tertiary marine sedimentary rocks exposed at intervals over a wide geographical range from North West Cape in Western Australia to north-western Victoria. The geological record over this area is very imperfect and no rigid conclusions may be drawn, but information is available to suggest that thermal conditions were very uniform over this and the whole of the Indo-Pacific region during most of the Tertiary, and no sudden change of temperature or ecological conditions led to the extinction of faunas between the end of the Eocene and the Middle Pliocene.

Evidence of the preservation of a Tethyan element in the fauna is based on the presence of species of the following subgenera, each having close relatives in the European or English Eocene and also in the Recent or late-Tertiary Indo-Pacific fauna: *Chlamys* s. str. with the *C. varia* series in the Parisian Eocene, and also in the Miocene and Pliocene of the Red Sea region and Zanzibar Protectorate (this series is fairly widely spread and would not in itself indicate a Tethyan element, but is regarded as worthy of note in view of the presence of the other undoubted Tethyan subgenera); *Lentipecten*, represented by *L. corneus* (Sowerby) in the English Eocene and *L. borneanus* (Cox) in the Pliocene of the North Borneo. *Arcturellina*, closely allied to the Parisian Eocene species *asperula, aizensis, prevosti, pulchra, ambiqua,* and *serrulata*, all of Deshayes; *Sportella* with *S. dubia* Defrance in the European Eocene and *S. jubata* living in North Queensland; *Monitilora* s. str. represented in the Parisian Eocene by *M. elegans* Defrance and the Australian Recent Peronian by *M. ramsayi* Smith; *Gibbolucina* with *G. ellipsoidalis* Cossmann and Peyrot in the Parisian Eocene, *G. callosa* (Lamarck) in the Indo-Pacific; *Bellucina* with *B. ligata* (Cossmann and Pissarro) in the Parisian Eocene, *B. eucosma* Dall in the Indo-Pacific; *Semivertagus* with *S. unisulcatum* Lamarck in the Parisian Eocene; *Coxellaria* (created below) related to *C. clava* (Lamarck) and *C. multispira* (Deshayes); *Globularia*, very like *Globularia sigaretina* Lamarck from the Calcaire Grossier. There are in addition the following subgenera common to the European Eocene, Adelaide Pliocene, and Recent Indo-Pacific which have not been studied in detail by the writer who accepts the authority of Wenz (Handb. der Palaozool, Gastropoda) that they occur in both the Tethyan Eocene and Recent Indo-Pacific faunas: *Semibittium, Margineulima, Fusinus, Tudicla, Aulicina* and *Gibberula*.

It is emphasised that, despite resemblances between certain elements in the fauna and elements in the Recent Indo-Pacific and the Tethyan Eocene molluscan faunas, the total composition of the faunas in each case is very distinct and local ecological conditions no doubt very rapidly produced divergent branches from a common stock. One of the most striking features is the general lack of specific resemblance between the Tertiary mollusca of the East Indies and Australia, although both appear to be influenced by a Tethyan Eocene element. As an example, of the mollusca described from the Pliocene of North Borneo (Cox, 1948) only two species may be regarded as showing any relationship to Australian Pliocene species; *Lentipecten borneanus* (Cox), related to *Lentipecten adelaidensis* sp. nov., and *Timoclea bataviana* which from external features appears to belong to *Veremolpa* and to be related to *V. protomarica* of the Dry Creek Sands and to *V. marica* of the Recent Indo-Pacific. It is therefore surprising to find so close an affinity between the Dry Creek Sands Pliocene and the Indo-Pacific Recent faunas.

C. The Australasian Element

Distinct from the tropical element which, as shown above, in some species represents a preservation of Tethyan features, is a large autochthonous element which has developed since early Tertiary times in Australia and which is not represented elsewhere other than to a limited extent in New Zealand. No work has been done in Australia to establish the lineages of the subgenera comprising this element, and it may at present be assumed to have arisen from a native stock. At this stage it is not possible to give the vertical stratigraphical ranges of the subgenera so that the horizons at which they separately first appear may be indicated.

The Australasian element, confined to Australia with the exception of those subgenera marked with an asterisk which occur also in New Zealand, is composed mainly of the subgenera *Ennucula, Neotrigonia,* **Cuna, Condylocardia,* **Myllita, Pseudarcopagia,* **Tawera, Anapella, Herpetopoma,* **Phasianotrochus, Euriclanculus, Starkeyna, Partubiola,* **Munditia, Bellastraea,* **Linemera, Ctenocolpus,* **Colpospira,* **Zeacumantus, Dannevigena,* **Evelynella,* **Zeacrypta, Tylospira,* **Ellatrivia, Notocypraea, Umbilia, Conuber, Sigaretotrema,* **Taniella,* **Tasmatica, Hypocassis Antephalium,* **Cymatiella* (also in Pacific), **Murexsul* (also in the Pacific), *Litozamia, Enatimene, Bedeva,* **Pleia, Cupidoliva,* **Austromitra, Iumitra, Austroharpa, Amoria, Ericusa, Sydaphera, Inquisitor,* **Filodrillia, Pervicacia.*

The lineages of subgenera common to Australia and New Zealand are not definitely established in Australia, although some are known in New Zealand at least from the Eocene and are not late Tertiary introductions with the Notonectian Immigration during the New Zealand Castlecliffian (Marwick, 1929). There was some addition of Indo-Pacific units to the New Zealand fauna during the early Tertiary (Marwick, 1925), although the Indo-Pacific element is very much weaker in the New Zealand than it is in Australian faunas. Australian elements may have been introduced during the early Tertiary also.

D. COSMOPOLITAN ELEMENT

The rest of the fauna is composed of cosmopolitan subgenera or those which have not as yet been sufficiently studied for any precise pronouncement upon their affinities to be made.

VII. AGE OF THE FAUNA

The problem of dating the faunas of the Australian region and of correlating them with the European time-scale has never been an easy one, and although much has been added to the knowledge of Australian Tertiary stratigraphy during recent years by study of the microfaunas, an accurate or reliable determination of the sequence and comparable time relationship has still to be made.

In the absence of restricted zone fossils the most reliable method appears to be to correlate the total faunal assemblages with faunas of established age elsewhere in the Australian and neighbouring regions.

There is no doubt that the Dry Creek Sands are post-Miocene. They rest with angular unconformity on beds not younger than Burdigalian and contain no restricted Miocene zone fossils. The mollusca, however, are almost totally unlike the Recent mollusca inhabiting the adjacent coastal waters, and any attempt to apply the method initiated by Lyell of assessing the percentage of living species would give an entirely erroneous result.

The table (fig. 3) has been constructed to show the composition of the fauna from the best information available at present. The "stage" names hitherto employed for Victorian and South Australian pre-Pliocene Tertiaries are here used only to give some indication of the length of range of the unrestricted species. They will be abandoned when accurate zoning of the strata is achieved.

Salient features of the analysis are:

1. The very low percentage (11) of Jemmy's Point ("Kalimnan") species.
2. The very high percentage (57) of restricted species.
3. The 10% of Recent species not occurring at Jemmy's Point.

This purely statistical evidence would suggest that the Dry Creek Sands are younger than the Jemmy's Point Formation ("Kalimnan"). The latter being accepted as Lower Pliocene in age, the Dry Creek Sands could then be regarded as late Lower Pliocene or early Middle Pliocene.

From the non-statistical viewpoint the exact correlation of the Jemmy's Point Formation and the Dry Creek Sands is limited by factors of distance and facies. The type section at Jemmy's Point, Kalimna, Gippsland, is 650 miles east of Adelaide. The strata in that locality were laid down without stratigraphical break (Crespin, 1943) in a sedimentary sequence embracing stages from at least Oligocene to Pliocene. The Dry Creek Sands were deposited after a period of denudation with a break in the Miocene-Pliocene sequence. There was during Pliocene times no connection by way of Bass Strait between the two areas. For this reason the term "Bass Strait Province" introduced by Crespin (1950, p. 423) is somewhat misleading,(1) since it implies the existence of Bass Strait prior to its foundering. The Jemmy's Point area was separated from the Pliocene seas to the west by the long peninsula of which Tasmania formed the southerly part, and diverse influences indubitably prevailed in the two areas.

"Kalimnan" species recorded from the Dry Creek Sands are frequently not typical. Whether this is due to stratigraphical or environmental facies variation is a question which can only be answered by close study of all Pliocene faunules over the geographical range between Adelaide and East Gippsland. Were the personal factor permitted to operate to the extent of separating some of the South Australian examples from the typical species, the number of restricted mollusca in the Dry Creek Sands would be even higher and the number of "Kalimnan" further reduced. On the other hand, as yet no detailed study similar to the present one has been made of the Jemmy's Point mollusca or of mollusca from Pliocene localities elsewhere in Victoria to enable one to express a confident opinion that some of the restricted Dry Creek Sands mollusca do not occur in the Victorian Pliocene. Furthermore, the fauna of the Dry Creek Sands differs markedly from that of the estuarine Pliocene strata of the Murray River. One can only emphasise that much detailed work remains to be done before the Pliocene sequence in Southern Australia is definitely established.

From the microfaunal aspect the only beds which have been correlated with the Dry Creek Sands are limestones in north-western Australia and on the Nullabor Plains from which the foraminiferal assemblage of the Dry Creek Sands has been reported (Crespin, 1950, p. 425).(2)

The New Zealand Waitotaran is more closely related to the Dry Creek Sands than is the Nukumaruan, and if any significance may be attached to trans-Tasman correlation of climatic conditions, the similar conditions prevailing during the South Australian Pliocene and the Waitotaran, with sudden extinction of tropical forms at the end of the period of deposition of the Dry Creek Sands may be worthy of note. The Nukumaruan was marked by a cold-water faunal immigration brought about by the advance and later retreat of subantarctic waters in the Middle Pliocene (Fleming, 1944, p. 209). It is certain that somewhat similar conditions existed in southern Australia where the Dry Creek Sands and their equivalents represent the last link with the tropical waters of the Indo-Pacific. The only suggestion of a gradual infiltration of colder water forms is provided by the presence in the Dry Creek Sands of the Flindersian foraminifera *Flintina triquetra* (Brady), *Cribrobulimina polystoma* (Parker and Jones) and *Nubecularia lucifuga* var. *lapidea* Wiesner, and Flindersian

(1) It is also liable to confusion with the term Bassian Province in use for the land fauna of Tasmania.

(2) As Miss Crespin has identified the foraminifer *Austrotrillina howchini* from what may be the same formation on the Nullarbor Plains, the second correlation requires confirmation.

mollusca not related to tropical forms, including *Nucula* (*Ennucula*) *beachportensis* Verco, *Nuculana* (*Scaeoleda*) *verconis* (Tate), *Limopsis vixornata* Verco, *Lissarca rubricata* (Tate) and *Lissarca rhomboidalis* Verco, *Bornia trigonale* (Tate), *Mysella ovalis* Tate, *Hiatella angasi* (Angas) *Batillaria* (*Zeacumantus*) *diemenensis* Quoy and Gaimard, *B.* (*Batillariella*) *estuarina* (Tate) *Trophon* (*Litozamia*) *goldsteini* Tenison-Woods, *Mitrella* (*Dentimitrella*) *lincolnensis* Reeve, *Retusa* (*Semiretusa*) *apiculata* (Tate), and *Volvulella rostrata* (Adams). These are all species of autochthonous genera which have probably evolved from endemic Australian elements.

DISTRIBUTION TABLE

SPECIES	BORE 189	207	89	178	57	169	81	14	51	6	65	5	106	17
Nucula (Ennucula) kalimnae Singleton	–	x	x	x	–	x	–	–	–	–	–	–	–	–
Nucula (Ennucula) beachportensis Verco	–	–	–	–	–	–	–	–	–	x	–	–	–	–
Nucula (Ennucula) venusta N. H. Woods	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Pronucula morundiana (Tate)	–	–	x	–	–	–	–	–	–	x	–	–	–	–
Nuculana (Scaeoleda) woodsi (Tate)	–	x	x	–	x	–	–	–	–	x	–	–	–	–
Nuculana (Scaeoleda) crebrecostata (T. W.)	–	–	x	–	–	x	–	–	–	x	–	–	–	–
Nuculana (Scaeoleda) verconis (Tate)	–	x	x	–	–	–	–	–	–	–	–	x	–	–
Arca negata (Cotton)	–	–	x	x	–	–	–	–	–	–	x	–	–	–
Barbatia (Barbatia) epitheca Cotton	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Barbatia (Acar) coma (Cotton)	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Cucullaea corioensis McCoy	–	–	x	x	x	–	–	–	x	–	–	x	–	–
Cucullaea praelonga Singleton	–	–	–	–	–	–	–	–	–	–	–	–	x	x
Limopsis beaumariensis Chapman	–	x	x	–	–	–	x	x	x	–	–	x	–	–
Limopsis maccoyi Chapman	x	–	x	x	x	–	–	–	–	–	–	–	–	–
Limopsis eucosmus Verco	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Limopsis vixornata Verco	–	x	–	–	–	–	–	–	–	x	–	–	–	–
Lissarca rubricata (Tate)	–	–	x	–	–	x	–	–	–	x	–	x	–	–
Lissarca rhomboidalis Verco	–	x	–	–	–	–	–	–	–	x	–	–	–	–
Glycymeris (Tucetona) convexa (Tate)	–	x	x	x	x	x	–	–	x	x	–	x	–	x
Glycmeris (Tucetilla) tenuicostata (Reeve)	–	–	x	–	–	–	–	–	–	x	–	–	–	–
Glycymeris (Veletuceta) subradians Basedow	–	–	x	x	–	–	–	–	x	–	–	–	–	–
Pinctada crassicardia (Tate)	–	–	x	x	x	–	–	–	x	–	–	x	–	–
Lopha hyotidoidea Tate	–	–	x	–	–	–	–	–	–	–	–	x	–	x
Ostrea arenicola Tate	–	–	x	x	–	–	–	–	x	x	–	–	–	–
Neotrigonia trua Cotton	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Chlamys (Chlamys) polyaktinos sp. nov.	–	x	x	–	–	–	x	–	–	x	–	–	x	–
Chlamys (Chlamys) antiaustralis (Tate)	x	–	x	x	x	x	–	x	x	x	–	x	x	x
Chlamys (Equichlamys) consobrina (Tate)	x	–	x	–	–	x	–	–	–	–	–	–	–	–
Chlamys (Mesopeplum) incerta (T. W.)	–	x	–	–	–	–	–	–	–	–	–	x	–	–
Lentipecten adelaidensis sp. nov.	x	–	x	–	–	–	–	–	–	–	–	–	–	–
Propeamussium atkinsoni (Johnston)*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hinnites corioensis McCoy	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Spondylus spondyloides (Tate)	–	x	x	x	x	x	–	–	x	–	–	–	–	–
Lima bassi T. W.	–	–	x	x	–	–	–	–	x	–	–	–	–	–
Anomia tatei Chap. and Sing.	–	x	x	x	–	–	–	–	–	–	–	–	–	–
Brachidontes hirsutus Lamarck	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Myadora alea Cotton	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Myadora tenuilirata Tate	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Myadora corrugata Tate	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Cleidothaerus adelaidensis Cotton	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Humphreyia strangei Adams	–	–	x	x	–	–	–	–	–	–	–	–	–	–
Humphreyia incerta (Chenu)	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Cuspidaria subrostrata Tate	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Eucrassatella camura (Pritchard)	–	x	x	x	x	–	–	x	x	x	–	–	x	x
Eucrassatella kingicoloides (Pritchard)	–	–	–	–	–	–	–	–	–	–	–	x	x	x
Cuna polita (Tate)	–	–	x	–	–	–	–	–	–	x	–	–	–	–
Cuna aporema Cotton	x	–	–	–	–	–	x	–	–	–	–	–	–	–
Cardita compta (Tate)	–	x	x	–	–	–	x	–	–	–	–	–	–	–
Cardita subdeceptiva sp. nov.	–	–	–	x	–	–	–	–	x	–	–	–	–	–
Glans spinulosa (Tate)	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Glans dennanti (Chap. and Cres.)	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Pleuromeris pecten (Tate)	–	x	–	–	–	–	–	–	–	x	–	–	–	–
Pleuromeris subpecten sp. nov.	–	x	–	–	–	–	–	–	–	x	–	–	–	–
Pleuromeris trigonalis (Tate)	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Cyclocardia (Scalaricardita) subcompacta (Chapman and Crespin)	–	x	–	–	–	–	–	–	–	–	–	–	–	–

SPECIES	BORE 189	207	89	178	57	169	81	14	51	6	65	5	106	17
Cyclocardia (Arcturellina) hindmarshensis sp. nov.	—	x	—	—	—	x	—	—	—	x	—	—	—	—
Cyclocardia (Arcturellina) peridonea sp. nov.	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Condylocardia tenuicostae Chap. and Gab.	—	—	—	—	—	x	—	—	—	x	—	—	—	—
Sportella jubata Hedley	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Chama lamellifera T. W.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Myrtea fabuloides (Tate)	—	x	x	x	—	—	—	—	—	—	—	—	—	—
Monitilora (Monitilora) idonea sp. nov.	—	—	—	—	—	—	x	—	—	x	—	—	—	—
Monitilora (Prophetilora) chavani sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Eomiltha (Gibbolucina) salebrosa (N. H. Woods)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Eomiltha confirmans sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Linga (Bellucina) nuciformis (Tate)	—	x	x	x	x	x	—	—	—	x	—	—	—	—
Callucina balcombica (Cossmann)	—	x	x	x	—	—	—	—	—	x	—	—	—	—
Gonimyrtea salisburyensis sp. nov.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Gonimyrtea crassior sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Gonimyrtea validior sp. nov.	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Gonimyrtea notabilior sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Miltha hora (Cotton)	—	—	x	—	—	—	—	—	—	x	—	x	x	x
Divalucina cumingi (Ad. and Ang.)	—	x	x	x	x	x	—	x	x	x	—	x	—	x
Diplodonta solitaria N. H. Woods	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Numella suborbicularis (Tate)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Thyasira sinuata (N. H. Woods)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Borna trigonale (Tate)	—	x	x	x	—	—	—	—	—	x	—	—	—	—
Litigiella adelaidensis sp. nov.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Myllita hindmarshensis sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Properycina micans (Tate)	—	—	x	—	—	x	—	—	—	—	—	—	—	—
Properycina torrensensis sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Platomysia sp.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Montacuta sericea Tate	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Mysella anomala Angas	—	—	x	x	—	—	—	—	—	x	—	—	—	—
Mysella ovalis Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Mysella macer N. H. Woods	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Mysella tellinoides N. H. W.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Vasticardium (Regozara) praecygnorum sp. nov.	—	—	x	x	—	—	—	—	—	—	—	—	—	—
Vasticardium (Vasticardium) submaculosum sp. nov.*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fulvia tenuicostata (Lamarck)	—	—	x	x	—	—	—	—	—	—	—	—	—	—
Nemocardium (Pratulum) proterothetidis sp. nov.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Dosinia (Kereia) johnstoni Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Notocallista (Striacallista) mollesta Marwick	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Notocallista (Striacallista) pestis Marwick	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Antigona cognata (Pritchard)	—	—	—	—	—	—	—	—	—	x	—	—	x	—
Antigona (Hina) cainozioca (T. Woods)	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Gafrarium perornatum N. H. Woods	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Tawera pernitida (N. H. Woods)	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Tawera gallinula Lam.	—	—	x	x	—	—	—	—	—	—	—	—	—	—
Tawera incurvilamellata sp. nov.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Chioneryx dennanti Chap. and Cres.	—	x	x	x	x	—	—	—	—	—	—	—	x	—
Placamen subroborata (Tate)	—	x	x	x	x	—	—	—	—	—	—	—	x	—
Bassina allporti (T. Wds.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Timoclea (Veremolpa) protomarica (Cotton)/	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Venerupis paupertina Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Gari hamiltonensis (Tate)	—	—	x	—	—	—	x	—	—	—	—	—	—	—
Gari aequalis (Tate)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Macomoralphi (Finlay)	—	x	—	—	x	—	—	—	—	x	—	x	—	x
Tellina masoni Tate	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Tellina albinelloides Tate	—	x	—	x	—	—	—	—	—	—	—	x	—	—
Pseudarcopagia detrita N. H. Woods	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Semele vesiculosa Tate	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Solecurtus dennanti Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—

SPECIES	BORE 189	207	89	178	57	169	81	14	51	6	65	5	106	17
Solecurtus subrectangularis N. H. W.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Mactra (Electromactra) howchiniana Tate	—	—	x	x	x	x	x	x	x	—	—	—	—	—
Anapella variabilis (Tate)	—	—	—	—	—	—	x	x	—	—	—	—	—	—
Zenatiopsis angustata Tate	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Corbula ephamilla Tate	—	x	—	x	x	—	—	x	x	x	—	x	—	x
Corbula adelaidensis nom. nov.	—	x	x	—	—	x	—	x	—	x	—	—	—	—
Hiatella australis (Lam.)	—	—	x	x	—	—	—	—	—	x	—	x	—	—
Hiatella angasi (Angas)	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Dentalium (Dentalium) howchini Cott. and Lud.	—	—	x	x	—	—	—	—	—	—	—	x	—	—
Dentalium (Fissidentalium) bifrons Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Dentalium (Fissidentalium) mawsoni sp. nov.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Dentalium (Antalis) denotatum sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Siphonodentalium (Pulsellum) adelaidense sp. nov.	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Cadulus (Dischides) yatalensis sp. nov.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Cadulus (Gadila) acuminatus Tate	—	—	x	x	—	—	—	—	—	—	—	—	—	—
Acanthochiton (Eoplax) adelaidae Ash. and Cott.*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chiton (Anthochiton) relatus Ash. and Cott.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cryptoplax ludbrookae Ashby	—	—	—	—	—	—	x	—	—	—	—	—	—	—
Haliotis (Notohaliotis) naevosoides McCoy	—	—	x	x	—	—	—	—	—	—	—	—	—	—
Emarginula didactica sp. nov	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Emarginula delicatissima Ch. and Gab.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Emarginula dennanti Ch. and Gab.	—	—	x	—	—	—	—	—	—	—	—	x	—	—
Emarginula dilatoria sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Tugali cicatricosa Adams	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Tugali infortunata Lud.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Tugali nota Cotton	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Amblychilepas acra (Cotton)	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Euchelus (Herpetopoma) pliocenicus (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Calliostoma (Laetifautor) obliquicancellatum (Lud.)	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Calliostoma (Laetifautor) spinicarinatum (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Calliostoma (Laetifautor) crebrinodulosum (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Calliostoma (Laetifautor) bicarinatum (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Astele (Astele) fanaticum Lud.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Astele (Pulchrastele) planiconicum (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Astele (Pulchrastele) tuberculatum (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Cantharidus (Phasianotrochus) laxegemmatus (Lud.)	—	x	x	—	—	—	x	—	—	—	—	—	—	—
Cantharidus (Phasianotrochus) subsimplex (Lud.)	—	x	x	—	—	—	x	—	—	x	—	—	—	—
Thalotia (Calthalotia) nitidissima (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Thalotia (Calthalotia) fictilis (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Clanculus (Euriclanculus) quadricingulatus Lud.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Clanculus (Euriclanculus) eucarinatus Lud.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Isanda (Minolia) pergloboso (Lud.)	—	—	x	—	—	—	x	—	—	—	—	—	—	—
Spectamen planicarinatum sp. nov.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Spectamen praecursor sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Gena incola Cotton	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Teinostoma depressulum (Ch. and Gab.)	—	x	x	—	—	—	—	—	—	x	—	x	—	—
Starkeyna pulcherrima (Ch. and Gab.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Tubiola (Partubiola) depressispira (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Tubiola (Partubiola) varilirata (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Crossea (Dolicrossea) cf. *labiata* T. Woods	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Collonia omissa sp. nov.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Astraea (Bellastraea) hesperus sp. nov.	—	—	x	—	—	—	x	—	—	x	—	—	—	—
Liotina (Munditia) tasmanica T. Woods	x	—	x	—	—	—	x	—	—	—	—	—	—	—
Phasianella dennanti Crespin	—	x	—	—	—	x	—	—	—	—	—	—	—	—
Pellax jejuna sp. nov.	—	x	—	—	—	—	x	—	—	x	—	—	—	—
Phenacolepas tela Lud.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Cocculinella salisburyensis sp. nov.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Tectarius (Nina) adelaidensis (Cott.)*	—	—	x	—	—	—	—	—	—	—	—	—	—	—

SPECIES	BORE													
	189	207	89	178	57	169	81	14	51	6	65	5	106	17
Amphithalamus (Pisinna) chrysalidus (Ch. and Gab.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Merelina (Linemera) varisculpta sp. nov.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Turboella praenovarensis sp. nov.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Turboella elimattae sp. nov.	—	x	—	—	—	—	x	—	—	x	—	—	—	—
Kaurnella denotata Lud.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Pseudoliotia angasi Crosse	—	—	x	x	—	—	x	—	—	—	—	—	—	—
Cingula (Pelecydium) cylindracea T. Woods	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Rissoina nivea Adams	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Rissoina elegantula Angas	—	x	x	x	—	—	—	—	—	x	—	—	—	—
Rissoina tinela sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Diastoma provisi Tate	—	x	x	x	x	x	x	—	x	x	—	x	x	x
Turritella (Haustator) acricula adelaidensis Cott. & Wds.	—	x	x	—	—	x	x	x	—	x	—	—	—	—
Turritella (Haustator) subacricula Cott. and Wds.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Turritella (Ctenocolpus) trilix Cott. and Wds.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Turritella (Colpospira) platyspiroides sp. nov.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Turritella (Peyrotia) murrayana subrudis Cott. & Wds.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Glyptozaria spectabilis sp. nov.	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Architectonica (Discotectonica) wannonensis (T. Woods)	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Tenagodus australis (Q. & G.)	—	x	x	—	—	—	—	—	—	—	—	x	x	—
Obtortio liratus Lud.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Batillaria (Zeacumantus) diemenensis (Q. & G.)	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Batillaria (Zeacumantus) multilirata (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Batillaria (Zeacumantus) bivaricata (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Batillaria (Batillariella) estuarina (Tate)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Manulona arrugosa Lud.	—	x	x	—	—	—	x	—	—	—	—	—	—	—
Manulona lirasuturalis Lud.	—	—	x	—	—	—	x	—	—	—	—	—	—	—
Ataxocerithium cf. *concatenatum Tate*	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Ataxocerithium bidenticulatum sp. nov.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Adelacerithium merultum Lud.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Diala (Mereldia) incommoda (Lud.)	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Bittium (Semibittium) subgranarium sp. nov.	—	—	x	—	—	x	—	—	—	x	—	—	—	—
Thericium (subg. n. nov.) *adelaidense* How. and Cott.	—	x	—	—	—	—	—	—	—	x	—	—	x	—
Thericium (subg. n. nov.) *pritchardi* (Harris)	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Thericium (subg. n. nov.) *fallax* (Lud.)	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Semivertagus capillatus Tate	—	—	x	x	—	—	—	—	—	x	—	—	—	—
Hypotrochus semiplicatus sp. nov.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Cerithiella (subgen. nov.) *trigemmata* Chap. and Cres.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Cerithiella (subgen. nov.) *perelongata* (Lud.)	—	—	x	x	—	—	—	—	—	—	—	—	—	—
Cerithiella (subgen. nov.) *superspiralis* sp. nov.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Triphora (Isotriphora) salisburyensis sp. nov.	—	x	x	—	—	—	x	—	—	—	—	—	—	—
Amaea (Amaea) triplicata (Tate)	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Cirsotrema (Dannevigena) sp.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Scala (Hirtoscala) sp.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Melanella (Margineulima) longiconica (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Melanella (Margineulima) minuticonia (Lud.)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Leiostraca (Leiostraca) acutissima Sowerby	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Niso psila T. Woods	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Syrnola (Syrnola) tincta Angas	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Syrnola (Agatha) praefasciata sp. nov.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Syrnola (Agatha) jonesiana (Tate)	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Syrnola (Agatha) infrasulcata (Tate)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Syrnola (Puposyrnola) tasmanica T. Woods	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Syrnola (Puposyrnola) acrisecta Lud.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Syrnola (Evelynella) adelaidensis Lud.	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Turbonilla) mariae T. Woods	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Chemnitzia) mappingae sp. nov.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Turbonilla (Chemnitzia) wurongae sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Chemnitzia) subfusca Lud.	—	—	x	—	—	—	—	—	—	x	—	—	—	—

SPECIES	BORE 189	207	89	178	57	169	81	14	51	6	65	5	106	17
Turbonilla (Chemnitzia) adelaidensis sp. nov.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Chemnitzia) currongae sp. nov.	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Chemnitzia) widningae sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Chemnitzia) sp.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Pyrgolampros) vixcostata Lud.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Pyrgiscus) "liraecostata" T. Woods	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Turbonilla (Pyrgiscus) radicans Chap. and Cres.	x	x	—	—	—	—	—	—	—	—	—	—	—	—
Cheilea adelaidensis Lud.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Hipponyx (Sabia) conica (Schum.)	—	—	—	x	—	—	x	—	—	x	—	—	—	—
Cerithioderma cf. *accrescens* (Tate)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Capulus circinatus Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Calyptraea (Sigapatella) crassa Tate	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Crepidula (Zeacrypta) immersa Angas	x	—	x	x	—	—	—	x	—	x	—	—	x	—
Crepidula (Zeacrypta) dubitabilis Tate	—	x	x	—	—	—	—	—	—	—	—	x	—	—
Crepidula (Zeacrypta) hainsworthi Johns.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Tylospira coronata marwicki (Fin.)	—	—	x	x	x	—	—	x	—	x	—	x	—	x
Proterato (Cypraeerato) subaustralis sp. nov.	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Ellatrivia wirrata Lud.	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Notocypraea eryma Cotton	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Umbilia cera Cotton	—	—	x	—	—	—	—	—	—	—	—	—	x	—
Globularia sp.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Polinices (Polinices) subjugum (Cotton)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Polinices (Conuber) subvarians (Tate)	—	—	x	—	x	—	—	x	—	x	—	x	—	—
Polinices (Conuber) cunninghamensis Harr.*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Polinices (Conuber) balteatella (Tate)	—	—	x	—	—	—	—	—	x	x	—	—	x	—
Sigaretotrema subinfundibulum (Tate)	—	—	x	—	—	—	x	—	—	—	—	—	—	—
Tanea hamiltonensis (T. Woods)	—	x	x	—	—	—	—	x	—	—	—	—	—	—
Taniella weymouthensis sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Proxiuber microsculptum sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Austrocochlis substolida (Tate)	x	x	x	—	—	—	—	—	—	—	—	—	—	—
Tasmatica modestina sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Cassis (Hypocassis) salisburyensis sp. nov.	x	x	—	x	—	—	—	x	—	—	—	—	x	—
Semicassis (Antephalium) muelleri Tate	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Semicassis (Antephalium) sufflata (T. Woods)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Semicassis (? Casmaria) radiata Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Argobuccinum bassi Angas	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Cymatiella adelaidensis Lud.	—	—	x	x	—	—	—	—	—	x	—	—	—	—
Charonia (Austrotriton) armata (Tate)	x	x	x	x	x	—	x	—	x	—	—	—	x	x
Charonia (Austrotriton) radiolis (Tate)	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Trunculariopsis peramangus (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	x	—
Hexaplex (Murexsul) suboctogonus sp. nov.	—	—	—	—	—	—	—	—	—	—	—	—	x	—
Hexaplex (Murexsul) biconicus (Tate)	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Pterynotus (Pterochelus) trinodosus (?) (Tate)	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Homolacantha antecedens sp. nov.	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Trophon (Litozamia) goldsteini T. Woods	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Trophon (Enatimene) metungensis Chap. and Cres.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Bedeva crassiplicata (Lud.)	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Typhis laciniatus Tate	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Latiaxis dissitus Cotton*	—	—	—	—	—	—	—	—	—	—	—	—	x	—
Mitrella (subgen. nov.) *lincolnensis* (Reeve)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Mitrella (subgen. nov.) *muscula* (Lud.)	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Mitrella (subgen. nov.) sp.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Mitrella (Ademitrella) insolentior (Lud.)	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Phos gregsoni Tate	x	—	x	—	—	—	—	—	—	x	—	—	—	—
Hinia (Reticunassa) spiraliscabra Chap. and Cres.	—	x	—	—	—	x	—	—	—	—	—	—	—	—
Hinia (Reticunassa) subconica sp. nov.	—	—	—	x	—	—	—	—	—	x	—	x	—	—
Fasciolaria (Pleia) sp.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Fusinus dictyotis (?) Tate	—	x	x	—	x	—	—	—	—	—	—	—	—	—

SPECIES	BORE 189	207	89	178	57	169	81	14	51	6	65	5	106	17
Olivella (Cupidoliva) nymphalis (Tate)	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Ancilla (Baryspira) tatei Marwick	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Ancilla (Turrancilla) adelaidensis sp. nov.	–	x	–	x	–	–	–	–	–	x	–	–	–	–
Austromitra angusticostata Lud.	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Austromitra mawsoni sp. nov.	–	x	x	–	–	–	–	–	–	x	–	–	–	–
Austromitra pauciplicata sp. nov.	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Austromitra multiplicata sp. nov.	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Mitraria (Eumitra) coxi sp. nov.*	–	–	–	–	–	–	–	–	–	–	–	–	x	–
Mitraria (Eumitra) glabra (?) Swainson	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Mitraria (Eumitra) sp.	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Mitraria (Eumitra) fodinalis (Tate)	–	–	x	x	–	–	–	–	x	–	–	–	–	–
Tudicla sinotecta Lud.	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Harpa (Austroharpa) tatei Finlay	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Cymbiola (Cymbiola) tabulata (Tate)	–	–	x	–	–	–	–	–	–	–	–	–	x	–
Cymbiola (Aulicina) uncifera (Tate)	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Amoria grayi Lud.	–	–	–	–	–	–	–	–	–	–	–	–	x	–
Ericusa ellipsoidea (Tate)	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Aphera (Sydaphera) wannonensis (Tate) *	x	–	–	x	x	–	–	–	–	–	–	–	–	–
Cancellaphera confirmans sp. nov.	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Marginella (Eratoidea) glaessneri sp. nov.	–	x	–	–	–	–	x	–	–	x	–	–	–	–
Marginella (Eratoidea) wentworthi T. Woods	–	x	x	–	–	–	–	–	–	x	–	–	–	–
Marginella (Eratoidea) meta Cotton*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Marginella (Eratoidea) crista Cotton	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Gibberula clima (Cotton) *	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gibberula talla (Cotton) *	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gibberula cassida (Cotton) *	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Closia moana (Lud.)	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Closia arena (Cotton) *	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Closia doma (Cotton)	–	x	–	–	–	–	–	–	–	x	–	–	–	–
Closia planilabrum sp. nov.	–	x	–	–	–	–	–	–	–	x	–	–	–	–
Serrata charma (Cotton)	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Serrata metula (Cotton) *	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Serrala bicrassiplicata sp. nov.	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Serrata weymouthensis sp. nov.	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Volvarina (?) *incommoda* sp. nov.	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Xenuroturris (Veruturris) tomopleuroïdes Powell	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Xenuroturris (Veruturris) bisculpta Powell	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Epidirona-adelaidensis (Lud.)	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Epidirona powelli sp. nov.	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Liratomina adelaidensis Powell	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Inquisitor detritus Lud.	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Inquisitor sp.	–	–	–	–	–	–	–	–	–	x	–	–	–	–
Splendrillia trucidata (Lud.)	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Splendrillia adelaidae Powell	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Syntomodrillia decemcostata (Lud.)	–	x	x	–	–	–	–	–	–	x	–	–	–	–
Syntomodrillia ludbrookae Powell	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Tomopleura ludbrookae Powell	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Maoritomella nutans Powell	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Guraleus (Guraleus) chapplei Powell	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Guraleus (Guraleus) ludbrookae Powell	–	x	x	–	–	–	–	–	–	x	–	–	–	–
Guraleus (Euguraleus) subnitidus Lud.	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Guraleus (Euguraleus) adelaidensis Powell	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Guraleus (Euguraleus) powelli sp. nov.	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Guraleus (s.l.) sp.	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Guraleus (Paraguraleus) abbreviatus Powell	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Guraleus (Paraguraleus) incisus Powell	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Mappingia acutispira Lud.	–	x	x	–	–	–	–	–	–	–	–	–	–	–
Mappingia matronalis sp. nov.	–	–	x	–	–	–	–	–	–	x	–	–	–	–

SPECIES	BORE 189	207	89	178	57	169	81	14	51	6	65	5	106	17
Etrema weymouthensis sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Etremopsis contigua Powell	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Filodrillia peramoena (Lud.)	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Filodrillia ludbrookae Powell	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Asperdaphne (Aspertilla) exsculpta Powell	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Nepotilla powelli sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Fenestrodaphne pulchra Powell	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Veprecula (?) *adelaidensis* Powell	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Pseudexomilus caelatus Powell	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Conus (Floraconus) hamiltonensis Tate	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Strioterebrum (Pervicacia) crassum (Tate)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Strioterebrum (Pervicacia) subspectabilis (Tate)	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Hastula (Nototerebra) tenisoni (Finlay)	—	—	x	—	—	—	—	—	—	x	—	—	—	—
Terebra (s.l.) spp.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Acteon scrobiculatus T. W.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Acteon sp.	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Semiactaeon tardior sp. nov.	—	—	x	—	—	x	—	—	—	—	—	—	—	—
Semiactaeon stratosculptum sp. nov.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Retusa (Semiretusa) canaligradata sp nov.	—	x	—	—	—	x	—	—	—	x	—	—	—	—
Retusa (Semiretusa) apiculata (Tate)	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Retusa (Semiretusa) coxi sp. nov.	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Volvulella rostrata (Adams)	—	x	x	x	—	—	—	—	—	—	x	—	—	—
Cylichna angustata (Tate and Coss.)	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Cylichna anticingulata sp. nov.	—	x	x	—	—	—	—	—	—	x	—	—	—	—
Scaphander tenuis Harris *	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Damoniella bullaeformis (Coss.)	—	x	—	—	—	—	—	—	—	x	—	—	—	—
Damoniella partisculpta sp. nov.	—	x	—	—	—	—	—	—	—	—	—	—	—	—

* From borings other than those tabulated.

ACKNOWLEDGMENTS

The writer is very greatly indebted to Dr. L. R. Cox of the British Museum (Natural History) for most generous help and advice throughout the work; to the Director and Trustees and to Mr. W. N. Edwards, Keeper of Geology of the Museum, for permitting most of the work to be undertaken there; to Dr. W. J. Rees and Mr. G. L. Wilkins of the mollusca section and to the librarians in the general, geology, and zoology libraries of the Museum for assistance in the search for material and literature; to Drs. Thorson and Lemche of the Universitetets Museum, Copenhagen, for the generous loan of type specimens; to Monsieur A. Chavan and Dr. Myra Keen for help with the classification of difficult groups; to the Director of Mines, South Australia, for the loan of the typescript of portion of a bulletin in the press on the Hydrology of the Adelaide Basin; and to Dr. M. F. Glaessner for the loan of additional material from the Tate Collection.

REFERENCES

BENSON, W. N. 1911 Note descriptive of a Stereogram of the Mount Lofty Ranges, South Australia. Trans. Roy. Soc. S. Aust., **35**, 108-111, pls. 20, 21

CHAPMAN, F. 1916 Cainozoic Geology of the Mallee and other Victorian Bores. Rec. Geol. Surv. Vict., **3**, (4), 327-430

CHAPMAN, F., and CRESPIN, I. 1935 Foraminiferal Limestones of Eocene Age from North-West Division, Western Australia. Proc. Roy. Soc. Vict., **48**, (n.s.), (1), 55-62

CHAVAN, A. 1949 Remarques sur la signification climatique des Mollusques marins fossiles. Bull. Soc. Geol. France, ser. 5, **19**, (7-9), 507-512

COTTON, B. C. 1947 Some Tertiary Molluscs from the Adelaidean Stage (Pliocene) of South Australia. Rec. S. Aust. Mus., 8, (4), 653-670

COX, L. R. 1948 Neogene Mollusca from the Dent Peninsula, British North Borneo. Schweiz. Pal. Abhandl., **66**, 1-70, pls. 1-9

CRESPIN, I. 1943 Stratigraphy of the Tertiary Marine Rocks in Gippsland, Victoria. Comm. Aust., Dept. Supply and Shipping, Min. Res. Surv. Bull. 9 (Pal. ser. 4). (Processed)

CRESPIN, I. 1950 Australian Tertiary Microfaunas and their Relationships to Assemblages elsewhere in the Pacific region. Journ. Pal., **24**, 421-429

CRESPIN, I., and COTTON, B. C. 1952 The Stratigraphy and Palaeontology of the Sub-surface Deposits of the Adelaide Plains. S. Aust. Dept. Mines Geol. Surv. Bull. 27, Appendix III, 227-238

DAVIES, A. M. 1934 Tertiary Faunas, **2**

FENNER, C. 1930 The Major Structural and Physiographic Features of South Australia. Trans. Roy. Soc. S. Aust., **54**, 1-36

FLEMING, C. A. 1944 Molluscan Evidence of Pliocene Change in New Zealand. Trans. Roy. Soc. N.Z., **74**, (3), 207-220. Two text figs.

GLAESSNER, M. F. 1951 Three Foraminiferal Zones in the Tertiary of Australia. Geol. Mag., **88**, (4), 273-283

HALL, T. S., and PRITCHARD, G. B. 1902 A suggested Nomenclature for the Marine Tertiary Deposits of Southern Australia. Proc. Roy. Soc. Vict., **14**, (2), 75-81

HOWCHIN, W. 1914 The Evolution of the Physiographical Features of South Australia. Rep. 14th Meeting Aust. Assoc. Adv. Sci., Melb., 1913, 148-178, pl. 3

HOWCHIN, W. 1923 A Geological Sketch Section of the Sea-Cliffs on the eastern side of Gulf St. Vincent, from Brighton to Sellick's Hill, with Descriptions. Trans. Roy. Soc. S. Aust., **47**, 283-315

HOWCHIN, W. 1928 The Building of Australia and the Succession of Life, pt. ii. Handb. Brit. Sci. Guild

HOWCHIN, W. 1929 Geology of South Australia, Ed. 2

HOWCHIN, W. 1935 Notes on the Geological Sections obtained by several Borings situated on the plain between Adelaide and Gulf St. Vincent., pt. i. Trans. Roy. Soc. S. Aust., **59**, 68-102

HOWCHIN, W. 1936 Pt. ii. Cowandilla (Government) Bore. Trans. Roy. Soc. S. Aust., **60**, 1-34

HOWCHIN, W., and PARR, W. J. 1938 Notes on the Geological Features and Foraminiferal Fauna of the Metropolitan Abattoirs Bore, Adelaide. Trans. Roy. Soc. S. Aust., **62**, (2), 287-317

KRUMBEIN, W. C., and SLOSS, L. L. 1951 Stratigraphy and Sedimentation. Freeman & Co., San Francisco

LUDBROOK, N. H. 1938 The Stratigraphical Position of the "Adelaidean" Beds of Pliocene Age, beneath Adelaide, South Australia. Aust. N.Z. Assoc. Adv. Sci., **23**, Auckland Meeting, 442-446

LUDBROOK, N. H. 1941 Gastropoda from the Abattoirs Bore, Adelaide, South Australia, together with a list of some miscellaneous Fossils from the Bore. Trans. Roy. Soc. S. Aust., **65**, (1), 79-102, pls. 4, 5

MARTIN, K. 1914 "Wann lösste sich das Gebiet des Indischen Archipels von der Tethys?" Samml. Geol. Reichs. - Mus. Leiden, ser, 1 **9**, 337-355

MARWICK, J. 1925 The Indo-Pacific Element in the Marine Tertiary of New Zealand Verh. Geol. Mijnb. Genvolsch (Geol. Ser.), **8**, 369-377

MARWICK, J. 1929 Geological Evidence of Past Land Connections of New Zealand. N.Z. Journ. Sci. and Technol., **11**, (3), 202-206

MAWSON, D., and SPRIGG, R. C. 1950 Subdivision of the Adelaide System. Aust. Journ. Sci., **13**, (3), 69-72

MILES, K. R. 1952 Geology and Underground Water Resources of the Adelaide Plains Area. S. Aust. Dept. Mines. Geol. Surv. S. Aust. Bull. 27

PARR, W. J. 1939 Foraminifera of the Pliocene of South-Eastern Australia. Min. and Geol. Journ. Vict., **1**, (4), 65-71

SEGNIT, R. 1940 Geology of Hallett Cove and District with special reference to the Distribution and Age of the Younger Glacial Till. Trans. Roy. Soc. S. Aust., **64**, (1), 3-44, pls. 1-3, 1 map

SINGLETON, F. A. 1941 The Tertiary Geology of Australia. Proc. Roy. Soc. Vict., **53**, (1), (n.s.), 1-125, pls. 1-3

SPRIGG, R. C. 1945 Some Aspects of the Geomorphology of Portion of the Mount Lofty Ranges. Trans. Roy. Soc. S. Aust., **69**, (2), 277-302

TATE, R. 1882 Notes on the Tertiary Strata beneath Adelaide. Trans. Roy. Soc. S. Aust., **5**, 40-43

TATE, R. 1890a On the Discovery of Marine Deposits of Pliocene Age in Australia. Trans. Roy. Soc. S. Aust., **13**, (2), 172-180

TATE, R. 1890b The Stratigraphical Relations of the Tertiary-formations about Adelaide, with especial reference to the Croydon Bore. Trans. Roy. Soc. S. Aust., **13**, (2), 180-184

TARE, R. 1889 On Deep-seated Eocene Strata in the Croydon and other Bores, Trans. Roy. Soc. S. Aust., **22**, (2), 194-199

TATE, R., and DENNANT, J. 1896 Correlation of the Marine Tertiaries of Australia. Pt. iii. South Australia and Tasmania. Trans. Roy. Soc. S. Aust., **20**, (1), 118-148

UMBGROVE, J. H. F. 1930 Tertiary Sea-Connections between Europe and the Indo-Pacific Area. Fourth Pacific Science Congress (Batavia-Bandoeng).

WENZ, W. 1938-1944 Gastropoda. Pts. i-vii. Handb. der Palaozool., **6**